3.0 AFFECTED ENVIRONMENT

3.1 INTRODUCTION

This chapter describes the existing physical, biological, cultural, social, and economic characteristics of the King Range National Conservation Area and its associated planning area. The affected environment defines the baseline of existing conditions from which possible impacts of the Proposed RMP may be analyzed. The majority of the data was provided by the BLM Arcata Field office; federal, state, county, and local agencies; various organizations; and other public and private sources. Data includes published and unpublished reports, maps, and digital format (GIS).

3.2 PHYSICAL ENVIRONMENT AND SETTING

3.2.1 Geology and Soils

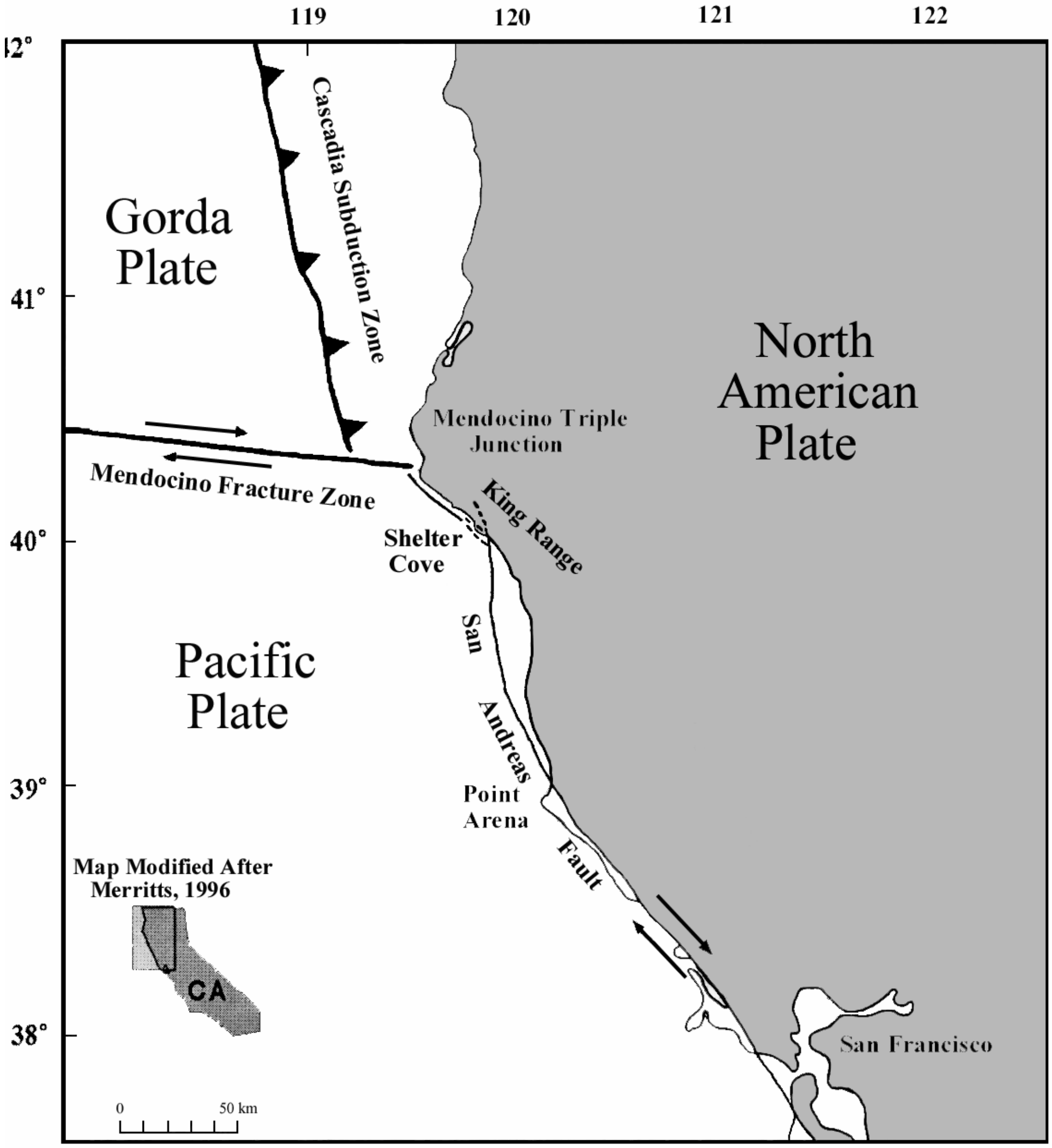
The combined geologic forces of the entire King Range area are continually reshaping the landforms of the Lost Coast, creating new habitat for stream, land, and marine life forms, and altering or completely eliminating habitat for others. Entire mountain sides are sometimes altered by storm and earthquake events in a matter of days, where in other parts of the world it would take hundreds or even thousands of years to achieve the same natural result. The King Range appears to be an area of geologic and climatic extremes, but it is also a place of uniqueness. Not only does it contain dynamic and fast changing mountain and coastal environments, dramatic beauty, and scenic coastlines, it is also a place where one can directly observe and walk upon the results of some very recent and great geologic forces.

3.2.1.1 Tectonics

The King Range lies just south of one of the most geologically active areas in North America. Three large tectonic plates converge just north of the King Range at a geologic feature known as the Mendocino Triple Junction, causing large and frequent earthquakes. The tremendous tectonic forces at the Mendocino Triple Junction and along the western front of the King Range have created high coastal mountain peaks, steep incised stream courses, and young coastal rock platforms. Geologists using radiometric dating and conducting coastal surveys have also determined that these compressional forces produce one of the highest geologic uplift rates in the world, which accounts for the high elevation and steep topography of the King Range (LaJoie et al. 1982, McLaughlin et al. 1983, Merritts 1989).

The geologic history and formation the Mendocino Triple Junction is very complex, but in general terms, three pieces of the earth's crust, called tectonic plates, are moving past and beneath each other in different directions (see Figure 3-1). This is unusual, as most earthquake-prone zones only involve two plates grinding against each other; the Mendocino Triple Junction represents one of the few places in the world where three plates meet close to land. North of the Junction, the Gorda Plate is being driven eastward beneath the North American Plate in what geologists refer to as the Cascadia Subduction Zone. This deep subduction zone is where most earthquake activity occurs in northwest California, and farther east and north creates the volcanic Cascade Range of mountains.

FIGURE 3-1: MENDOCINO TRIPLE JUNCTION



South of the Junction and along the western edge of the King Range, the San Andreas Fault forms the boundary between the Pacific and North American Plates; though much of its trace north of Point Arena lies beneath the ocean, geologic evidence suggests it bends shoreward briefly at Shelter Cove. The fault motion between these two plates is a sliding "strike-slip motion," with the Pacific Plate moving northwest and the North American Plate sliding southwest. The King Range rests on the North American Plate and moves with the plate on its southwest course.

West of the Junction, out at sea, the Pacific and Gorda Plates slide past each other in an east-west motion, forming a transform fault known as the Mendocino Fracture Zone. The east-west sliding motion also generates large sub-sea earthquakes felt throughout the entire region. This fracture zone represents further bending of the San Andreas Fault, where it turns west from its trace along the coastal edge of the King Range.

In March 1992, three large earthquakes, measuring magnitudes 7.1, 6.6, and 6.7, struck an area immediately north of the King Range (the first quake was centered close to Petrolia, the two aftershocks offshore) at the Mendocino Triple Junction, and submerged land was dramatically uplifted from the ocean near the sites of these earthquakes. Intertidal rock platforms and beaches were raised as much as four feet above sea level, creating new tidal areas seaward while stranding marine organisms and eliminating some tidepool habitat closer to shore.

Before the 1992 earthquakes, Dr. Kenneth R. LaJoie, a research geologist at the U.S. Geological Survey, had mapped the low elevation marine terraces at Cape Mendocino just north of the King Range. He suspected that the unique bedrock features and beach ridges found along the entire Lost Coast might have formed during very large and recent earthquake events. Using radiometric carbon14 methods to date fossils and driftwood deposited in the terraces at Cape Mendocino, he determined that the lowest marine terrace was only 3,100 years old. LaJoie had suspected that this young marine terrace and other platforms further south along the western front of the King Range might have been uplifted suddenly during an earthquake event. The new coastal land surfaces that were uplifted during the 1992 earthquakes confirmed his theory. Further mapping and geologic dating by Merritts and Bull (1989) showed that multiple uplifted surfaces of various ages extend south along the entire Lost Coast. It is now generally accepted that these young marine platforms were created suddenly during earthquake events during the last 5,000 years.

Evidence of past earthquake events can be viewed along most the shoreline of the King Range in the form of older "fossil" marine platforms cut into the bedrock at higher elevations above the present day tidepools. These marine terraces represent not only geographic stair steps, but also steps back into recent geologic time with the youngest platforms at the lowest elevation, near the present shore line, and the oldest terraces at higher elevations further from shore.

Older marine terrace deposits are found near the southern end of the King Range, exposed in the sea cliffs at Shelter Cove. The relatively flat westward portion of Shelter Cove is made up of marine beach gravels and sands overlying on an uplifted marine bedrock terrace. This terrace was previously dated at approximately 40,000 years, much older than the low coastal terraces to the north. Dating of the Shelter Cove terrace was determined using carbon14 dates from fossil spruce cones in the young deposits overlying the terrace (McLaughlin et al. 1983), but recent geologic work on these same deposits indicate they may be slightly older, with dates in the 60,000 to 100,000 year range (Merritts et al. 2000). Immediately to the east, the marine terrace deposits are overlain by older landslide deposits which form the grassy and forested slopes above the Shelter Cove.

Much of the Lost Coast Trail, which extends along the beach from the Mattole River south to Shelter Cove, travels over uplifted rock platforms formed during very large earthquakes. If it were not for the tremendous geologic forces that uplifted this coastal area during the last few thousand years, much of the flat platform that the Lost Coast Trail rests upon would not be available for hiking and camping today. The marine tidepools found along the shoreline of the King Range have also evolved from this series of recent uplift events and earthquakes. The excellent surfing at Big Flat north of Shelter Cove owes its existence to the same forces, with the waves breaking on an uplifted but still submerged bedrock reef close to shore. Rocks and small islands located just off the coast are made up of erosion-resistant remnants of marine platforms.

The famous San Andreas Fault has been mapped at Shelter Cove, its trace passing northwest through the upper slopes immediately east of the cove and entering the seafloor near the mouth of Telegraph Creek. This map trace was established shortly after the 1906 San Francisco earthquake, based on the mapping of ground breakage and fractures immediately after the earthquake. Since that time other geologists have proposed that the actual trace of the San Andreas lies offshore, and that the ground fractures mapped in 1906 were caused instead by landsliding (McLaughlin et al. 1983). However, the issue of where the San Andreas Fault trace actually lies in the vicinity of Shelter Cove is still not settled. A new team of geologists from the U.S. Geological Survey, who have re-mapped and trenched the geologic features at Point Delgada, proposed that the fault may indeed lie on land just east of Shelter Cove, in the vicinity or just east of the old 1906 fault trace near Black Sands Beach and Telegraph Creek (Prentice et al. 1999).

3.2.1.2 Rock Types and Age

Though the topographic features such as the high mountains and the uplifted bedrock platforms along the King Range are geologically young, they are composed of very old bedrock. Most of these rocks formed from deep ocean sediments and volcanic eruptions beneath the sea starting in the Cretaceous period, 60 million years ago, and continuing until the Eocene epoch, 40 million years ago. Some small outcrops of younger sandstone and shale, dating to the middle Miocene epoch, 15 to 24 million years ago, have also been discovered along the Lost Coast (McLaughlin et al. 1982).

In a simplified model, the rocks were transported in a conveyer belt-like fashion eastward on oceanic plates to the adjacent continental plate, where they were folded against and subducted beneath the older continental plate. Repetition of this subduction and deformation process over time formed fault-bounded belts of highly folded and fractured rocks, with the youngest rocks located on the western boundary of the adjoining continental plate. Some of the rocks that were subducted beneath the continental plate were altered by heat and pressure, then raised to their present position by faulting and folding, and later exposed by erosion. This subduction and accretion process formed most of the California Coast Ranges, including the King Range.

The rock types of the King Range are mostly marine sandstones and shale, but there are also minor occurrences of chert, conglomerate, and volcanic basalt (see Figure 3-2). The entire suite of rocks are grouped together in Franciscan Complex, a geologic formation which is divided into many fault bounded blocks of varying ages called "geologic terranes." Locally this group of Franciscan rocks is aptly called the King Range Terrane. Geologists have further divided the King Range Terrane into the King Peak and Point Delgada units, based on slightly different rock types and age differences. All of the rocks have undergone both shearing and folding, but folded rocks were found to be the most common (McLaughlin et al. 2000).

The younger King Peak unit of the terrane consists of mostly sandstone and shale, with some outcrops of conglomerate and rare occurrences of igneous rock in the form of basalt. Small outcrops of limestone and ribbon chert are sometimes associated with the basalt.

The age of the rocks in the King Peak unit was thought to be the Eocene epoch, but some of these rocks have recently been dated to be from the middle Miocene epoch based on fossil evidence (McLaughlin et al. 1982).[1] There are no important mineral deposits in this group of rocks, with the exception of a small deposit of manganese that was mined by hand briefly during the mid-1950s from chert deposits at the Queen Peak Mine on the south fork of Bear Creek, then trucked to Arizona for processing.

The older Point Delgada unit of the King Range Terrane has a more complex range of rock types, well exposed at Shelter Cove in the tidal zone. These rocks include altered or metamorphosed sandstones and shale, and small outcrops of limestone, along with pillow basalts and other volcanic rocks such as volcanic tuffs, basaltic sandstones, and flow breccias. (McLaughlin et al. 2000). These volcanic rocks are the result of deep undersea volcanic eruptions approximately 60 million years ago. In addition there is a zone of tectonically sheared shale or "mélange," which contains blocks of glaucophane blue-schist, chert, quartzite, and other volcanic rocks. Microfossils from this rock complex date from the Late Cretaceous period, much older than the above-mentioned King Peak unit. In some isolated areas hydrothermal waters have locally altered some of the rocks to form small veins of minerals such as pyrite, chalcopyrite, sphalerite, and galena (McLaughlin et al. 2000).

3.2.1.3 Soils and Geomorphology

The geologic forces at the Mendocino Triple Junction and frequent earthquakes, along with extreme climatic conditions, are responsible for shaping rugged topography and high mountain relief of the King Range. These same forces have also sheared and fractured large zones of rock, making them weak in some areas and susceptible to erosion and large landslides. High rainfall in the King Range, often reaching over 150 inches per year, accelerates the erosion process, especially in the rocks weakened by shearing and faulting, and landslides occur frequently.

On the western slope of the King Range, landslides discharge large amounts of rock and soil into coastal streams. As the materials are transported downstream to the flat marine platforms, they may form large alluvial fan deposits such as those found on Spanish Flat and Big Flat. These alluvial fans are often used by hikers along the Lost Coast Trail as resting or camping spots, as they are flatter and more open than much of the coastline.

Large blocks of the more resistant sandstone form the steeper, sharp-crested slopes of the King Range such as King Peak, the highest point in these coastal mountains. These high ridges parallel the coastline and reach elevations near 4,000 feet within three miles of the shore, with western slopes dropping precipitously to the ocean. These steep slopes shed large amounts of surface rock and soil debris in the form of debris slides which sometimes reach all the way to the ocean shoreline. A recent example of this type of slide intersected the Lost Coast Trail during the winter in 2003 near Buck Creek.

Three dominant rock types control most of the topography and soil formation throughout most of the King Range: 1) isolated blocks of resistant massive sandstone, 2) zones of sheared shales, and 3) combinations of shale and sandstone found as thin interbeds or small sandstone units interrupted by shale beds. The massive or thick bedded sandstones form steep rocky faces with crested ridges,

[1] Fossils are extremely rare in this portion of the King Range, but age dating of the rocks has been determined using microscopic fossils such as foraminifera and diatoms found in the cherts, limestones, and some shales.

weathering to form sandy and silt rich soils found on the more stable slopes. Small side hill drainages in this rock type tend to be straight, well incised, and evenly spaced (McLaughlin et al. 2000). Examples of this type of topography are found along the Rattlesnake Ridge area near King Peak.

More resistant sandstone forms the sharp crested mountains in the King Peak area.

The sheared shales weather to clayey soils and are structurally weak. Hill slopes with these rock and soil types tend to have rounded topography on the upper slopes and ridge crests with poorly incised side hill drainages. Excellent examples of this type of topography, soil, and bedrock can be found on the slopes and ridges immediately north and south of Cooskie Creek, along the western edge of the King Range.

Where the rock types are mixed shale and sandstone and are more heterogeneous, the hillslopes form more irregular slopes with intermediate steepness. According to observations by McLaughlin (2000), side hill drainages in these areas run directly downhill, have irregular spacing, and slopes have an irregular form or lumpy form. This type of landform can be found in the Horse Mountain Creek watershed.

Overall the landforms and soils types of the King Range blend together in soft mosaic when viewed from a distance or from the air. But each rock type, its structure, and weathering factor determines what landform and soil type will ultimately form. These geologic factors, when combined the sun angle, elevation, and ocean proximity, also determine the vegetation pattern of the King Range. The predominantly unstable soils, high rainfall (see below), and seismic activity require careful siting of roads, trails and facilities, as well as continuous maintenance to prevent their erosion and failure.